or axis of vibration will describe the surface of two cones having their common apex in the axis of rotation.

The axis of a flexible pendulum can only assume a position vertical to the point of the earth's surface over which it is placed. Were it possible to maintain the vibration of a stretched wire occasioned by an original impulse, for a sufficient length of time, the apparent rotation of its plane of vibration would vary with the inclination of the wire to the axis of the earth: placed in this axis, it would make a rotation in 24 hours, it would become progressively slower according to the law above given, as it approaches the plane of the equator, and when anywhere in this plane the vibrations would always be performed in the same direction.

2. "Report of further Observations made upon the Tidal Streams of the English Channel and German Ocean, under the authority of the Admiralty, in 1849 and 1850." By Captain F. W. Beechey, R.N. Communicated by G. B. Airy, Esq., F.R.S. &c., Astronomer Royal. Received March 27, 1851.

This is the continuation of a report which the author made upon the tidal phenomena of the Irish Sea and English Channel in 1848. After detailing the manner in which the investigation had been conducted, and the great care which had been bestowed upon the observations, which are numerous, the author enters into an explanation of the whole system of tidal streams in the English Channel and North Sea, as deduced from these observations, and also as to what he considers to be the cause of the peculiar movement of the streams in these channels. He supposes, in conformity with Dr. Whewell's theory, a tide-wave to pass along the western shores of Europe, and to enter the English Channel and North Sea by opposite routes, and to arrive off the Texel and Lynn at the same tidal hour as the tide-wave in the English Channel arrives off the Start and Jersey. From these points there are thrown off branch or derivative waves, which differ materially both in dimensions and rate of travelling from the parent wave. These waves roll on towards the strait of Dover and there merge into each other and form a combined wave.

The effect of this wave upon the tidal establishments of the Channel had long been known; but its influence upon the streams of the Channel had never before been considered, nor had any observations upon them been systematically undertaken.

In arranging the plan of observation the author considered that, as the combined wave was common to both the English Channel and North Sea, the tidal streams of both these channels would be found to correspond in every important particular, and that the movement of the streams throughout the strait would be materially influenced, if not wholly governed, by the motion of the combined wave; that the time of this wave attaining its greatest altitude would thus afford a standard to which the turn of the streams throughout the Channel might be advantageously referred; and that there would be found in this Channel, as in the Irish Sea, which is equally under the influence of a combined wave, a stream which would turn nearly

simultaneously throughout the strait with the times of high and low water on the shore at the point of combination or virtual head of the tide.

Accordingly the observations were conducted upon this plan, and all the movements of the stream were referred to the time of high water at Dover, which had been determined upon as the standard from its being situated nearly at the point where the combined wave is formed. It appeared from the intervals which this mode of comparison afforded, that whilst the water was *rising* at Dover, the stream of the channels on both sides ran *towards* that place; and on the contrary, in the *opposite* direction whilst the water was *falling* there; and that these streams pursued a steady course throughout the tide, and extended from a line joining the Texel and Lynn, in the North Sea, to a line joining the Start and Jersey in the English Channel. Beyond these limits the streams of the Channel were found to encounter those of the offing or parent wave, and to occasion the tides in those localities to partake of a rotatory character, revolving for the most part with the sun, and having scarcely any interval of slack water.

The line of meeting of these streams was found not to be a stationary line, neither in those parts where the Channel-stream encounters the offing stream, nor where the streams meet in the strait of Dover, but was found to shift from west to east as the tide rises and falls at Dover, beginning at Beachy Head and ending at the North Foreland; so that the space occupied by the Channel-stream always preserves the same dimensions, notwithstanding its limits extend over a distance of 360 miles. The strait of Dover was found never to have slack water throughout its whole extent at any time, as was the case in the other ports of the Channel, from which it differs in this respect; and the streams in this locality have in consequence been designated as those of the "Intermediate tide."

As the simultaneous turn of the stream throughout the Channel is a point of considerable interest and entirely new, the author takes considerable pains to point out the methods by which this important fact was ascertained, and refers to the observations kept on board the light vessels along the coast, and to others made at various important stations; and whenever any contradictory evidence appears, the cause of the discrepancy is inquired into and explained. It was found, for instance, that in a port of the North Sea, near the node referred to by Dr. Whewell, there was a retardation of an hour in the turn of the stream; and, upon an investigation as to the cause of this delay, it is seen to be owing to the stream running round the Texel and entering the North Sea at a time when the Channel-stream had ceased; but as soon as the Channel-stream acquired sufficient strength, it speedily drove the Texel stream back and confined it to its proper limits. In the English Channel also a similar discrepancy is observable near the coast of France; but this also the author considers to be fully accounted for by causes incidental to that part of the Channel, and not to be of sufficient con-

sequence to derogate from the character ascribed to the general motion of the water throughout the strait.

A reference is made to the erroneous opinions which have hitherto been entertained with respect to the motion of the streams of our channels; and the author concludes his paper by explaining his views as to the manner in which the turn of the stream is rendered simultaneous by the rapid rise of the combined wave in the centre of the strait, and expresses a hope that he has satisfactorily shown from the observations, that throughout the English Channel and North Sea the movement of the stream may safely be referred to a common standard. This, it is considered, will be of great importance to navigation; as thus the seaman's progress through these moving waters will be freed from the numerous and perplexing references he was before obliged to make, and which too often—and, it is to be feared, in many instances too fatally—caused the tides to be wholly disregarded. All uncertainty as to the effect of the stream will henceforward, it is expected, be obviated by a simple reference to a tide table.

The paper, which is accompanied by numerous plans and charts, forms a practical illustration of the tidal streams of straits, under the influence of a combined wave.

May 22, 1851.

The EARL OF ROSSE, President, in the Chair.

Edward Schunck, Esq. was admitted into the Society.

Mr. James Smith gave notice, that at the next meeting of the Society he would propose His Grace the Duke of Argyll for immediate ballot, to which as a peer of the realm His Grace is entitled.

The following papers were read:—

1. "Additional Observations on the Diffusion of Liquids." By Thomas Graham, Esq, F.R.S., F.C.S. &c. Received March 27, 1851.

The experiments detailed in this paper were conducted with the same apparatus and in the same manner as those described in the author's two former papers on this subject. The diffusion was generally made from four different proportions of each solution, so as to exhibit pretty fully the character of the salt in reference to this property. The salts operated upon were of two bases only, potash and soda, but the acids were considerably varied, so as to include the hydrates, carbonates, sulphates, sulphites, hyposulphites, sulphovinates, oxalates, acetates and tartrates of these bases.

The times chosen for the corresponding potash and soda salts, with the view of obtaining equal diffusions, were always in the proportion of 1·4142 to 1·7320, that is, as the square root of 2 to the square root of 3. Eight cells were diffused of the 1 and 2 per cent. solutions, and four cells of the 4 and 8 per cent. solutions. The salts were always taken anhydrous.